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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of:	PATENT
Mats LEIJON	Group Art Unit: 2832
Serial No.: 08/973,210	Examiner: M. Nguyen
Filed: April 3, 1998	Atty Docket: 66291-182-2

TRANSFORMER/REACTOR

DECLARATION UNDER 37 C.F.R. §1.132

I, Ken Linsley, hereby declare

1. I am presently Vice President of Manufacturing for EHV-Weidmann Industries Inc. I live in Danville, Vermont, where my mailing address is P.O. Box no. 273 Danville, Vermont 05828-0273.

2. My academic background is as follows:

   Bachelor of Arts, Brown University, 1967

   Bachelor of Science in Electrical Engineering, Brown University, 1967

3. My industry experience is as follows:

I have over 30 years of experience in the area of high power transformer design, the most notable positions as follows:

1967-1978: Increasing positions of responsibility in the engineering design function of power transformers with Westinghouse Electric Corporation in Sharon, PA. Final position was Engineering Section

Manager with responsibility for product design of oil insulated substation transformers through 33,333 kVa and 230,000 volts, with and without load tap changing.

1979-1989: Engineering Manager, Small Power Transformer Division, Westinghouse Electric Corporation, South Boston, VA, with responsibility for product design and development of oil insulated power transformers through 12,500 kVa and 69,000 volts. This included load tap changing and open wound dry type transformers.

1989: Vice President-Engineering for Hevi-Duty Electric with responsibility for development and design of oil insulated power transformers through 40,000 kVa and 138,000 volts.

1989-1992: General Manager, Medium Power Transformer Plant, ABB Power T&D Company with responsibility for product design and development, manufacturing and test of oil insulated power transformers through 100,000 kVa and 230,000 volts and repair of units through 200,000 kVa and 345,000 volts.

1992-1995: Vice President and General Manager, Small Power Transformer Plant, ABB Power T&D Company Inc with overall responsibility for product design and development, marketing, manufacturing, test and Quality Assurance for oil insulated power transformers through 12,500 kVa and 69,000 volts.

1995-1997: Director, Research and Development, ABB Distribution Transformers. This included worldwide responsibility for design concepts and research and development efforts for a business volume of 1 billion dollars. The product range extended through 12,500 kVa and 69,000 volts. This included oil insulated, open wound and cast resin epoxy product types. Also included was load tap changing. This required a close working association with ABB Power Transformers.

1997- : Vice President of Manufacturing, EHV-Weidmann Industries Inc. We are a supplier of insulation materials and components to the power and distribution transformer industry.

4. My professional background is as follows:

(1) Past Chairman, ANSI C57 Standards Committee (Transformers) -- This committee is the consensus (public & private) standards making body in the United States for transformer standards.

(2) Past Chairman, ANSI C57.12.1 Committee

(3) Five published articles relating to power transformer design and application

(4) Member, IEEE, Power Engineering Society

(5) Multiple presentations to technical and commercial groups relating to power transformer design, application and maintenance.

5. In preparing this Declaration, I have read and considered at least the following documents pertaining to the above-identified patent application:

(1) Patent application - U.S. Serial No. 08/973,210;

(2) Office Action of November 24, 2000; and

(3) Applicant's Response.

Furthermore, I have read the following references, all of which have been asserted as prior art against the present invention:

(1) Grimes et al. (U.S. Patent No. 5,455,551)

(2) Elton et al. (U.S. Patent No. 4,853,565)

(3) Takaoka et al. (U.S. Patent No. 5,094,703).

6. Electric power transformers are energy conversion devices used to step up voltage produced by a generator to the higher voltage level for transmission and distribution of power and to step down the voltage for delivering electric power to the end-users. Designers of electric power transformers are concerned with the most efficient conversion of power (i.e. low losses) as well as the longevity of the device itself, and safety.

7. Electric transformers operate most efficiently when the flux produced in the transformer is concentrated or confined to as small a space as possible.

8. The flux can be concentrated using a number of known winding techniques. However it is particularly important to minimize as much as possible the space between the conductors forming the turns of the transformer. This is achieved by positioning the turns' windings in such a way that primary and secondary conductors are assembled interspersed in a closely packed matrix. In conventional transformers close packing is achieved by positioning of turns close together and through the use of rectangular wire. The use of a round, current carrying conductor would imply wasted space in the core window. Even in distribution transformers, round wire is typically flattened to increase the space factor or percentage of window that is filled with active conductor.

9. At the same time it is important to reduce as much as possible electric field stress which

occurs in regions of high electric field intensity. This can be caused by any irregularities e.g. impurities or air filled voids in the insulation, or by irregularities at the interfaces between adjacent layers. High-intensity fields present at such locations can lead to a breakdown in the insulation, requiring repair or replacement of the transformer at great expense and inconvenience.

10. In conventional high power transformers, electrical stress is generally controlled using paper insulation. Some systems, in addition, use impregnation techniques to produce an oil integrated winding structure being generally free of air pockets which can cause partial discharge and ultimately damage the winding. Even so, these regions of high electrical stress are difficult to control.

11. In conventional high power transformers, considerable heat is produced and must be dissipated. Typically this is achieved by locating the windings in a container and immersing the windings in an insulating liquid coolant, and by using heat exchangers external to the container in which the windings are immersed. The electric field produced in the windings is thus controlled by the combination of paper insulation and liquid coolant insulation; and the electric field is confined within the container. The arrangement is complex, costly, adds size and is difficult to maintain.

12. It is generally known by transformer designers that, in order to reduce resistive losses in the winding, the cross-section of the conductors forming the winding can be increased. There are,

however, other design constraints that must be considered, in particular, the size of the resulting winding and the compactness of the flux produced therein.

13. If the insulation employed to control intra and inter winding electric field stress is increased in order to control the electric field stress, the size of the winding is increased and the efficiency of the transformer is reduced. This is undesirable because even a small reduction in efficiency will result in a large increase in operating cost. The use of additional turn insulation will have several negative effects:

(1) The amount of conductor used in the winding will increase with attendant cost increases;

(2) The losses will increase due to the increased length of the conductor;

(3) The thermal drop across the thicker insulation will be higher resulting in higher winding temperatures; and

(4) The series capacitance of the winding will change, which will likely increase the severity of stresses resulting from voltage impulses (for example, lightning strikes, switching surges, and the like).

14. In a high power transformer, it is therefore desirable to reduce as much as possible the amount of insulation required, while maintaining electric field stress control.

15. I am not an expert on cable systems, but I am advised that insulation systems in cables for transmission and distribution of electricity are provided around the conductor to ensure that the electric field is contained within the insulation. I am advised that the insulation system consists in principle of three layers, first an electrically conductive layer surrounding the conductor being firmly bonded to a second insulation layer surrounding the first layer, and a third layer of electrically conductive material being firmly bonded to and surrounding the second layer. The insulation layer is typically an extruded material, for example cross-linked polyethylene (XLPE) or ethylene propylene rubber (EPR). The most essential properties of the insulation material are low dielectric losses (i.e. low dielectric constant and loss angle), high dielectric strength, flexibility and permanence.

16. Cables have a relatively large diameter and can both retain and give-off heat. However, I understand that heat dissipation can be solved with today's solutions and is not a big problem in electric transmission cable design. For cables, the heat issue has been addressed over the years, as such cables are not new. I know that cables can be direct buried, or sometimes placed in thermal sand to facilitate heat removal, or placed in a conduit for ease of replacement or mechanical protection. Although I'm not a cable expert, I expect that cables exposed to still but unconfined air would not pose a problem. However, cables wrapped tightly around a core in a transformer would be caused to experience a condition of thermal stress. This is the difference between a transformer application of the winding and a transmission or distribution cable for transmitting

power.

17. In a cable, insulation layers are made homogeneous. In some arrangements, two conductive layers serve as concentric equipotential surfaces, the outermost layer is kept at ground potential by contact with a grounded metal screen. The metal screen is dimensioned to carry fault currents.

18. The cost of a failure in an electric power transmission cable can be extremely high. It is therefore important that the cables are designed to withstand the harsh environment to which they will be exposed. Accordingly, electric power transmission cables include a protective sheathing. The protective sheathing may be made of an electric insulating polymeric material or a conductive metal covering.

19. In a transformer, currents are induced in the conductive windings by interaction with the changing magnetic field. Thus, if a conventional cable for the transmission and distribution of electricity is employed as a winding in a transformer, the conductive shield layer and the outer protective sheath will have induced therein electrical currents which would be highly undesirable.

20. In my opinion therefore it would not be desirable to employ a cable for distribution and transmission of electrical power as the winding in a high power transformer. In my view, such an arrangement would not operate satisfactorily, and would likely result in failure of the device.

Another concern that I would have with the use of cables would be their ability to withstand the high mechanical forces and associated high temperatures associated with short circuits. I would expect that there could be some reduction in the thickness of the insulation at pressure points between conductors as the polymeric insulation might flow due to the extreme pressures and temperatures to which the cables would be subjected. To use such a material as a part of a transformer winding insulation system is certainly not obvious.

21. Given the different operational environment, it is understandable that transformer engineers are greatly concerned about the heat produced in the confined space of the device. Accordingly, transformer engineers focus on high temperature insulation systems. Most oil insulated cellulosic (conventional) based insulation systems utilize a Class A insulation system or one that can be expected to withstand temperatures of 110^{0}C and still provide a normal life. The materials used in transformers should be high temperature materials with high degree of resistance against partial discharge (PD).

22. In my opinion, the solid extruded insulating systems used in power transmission cables (e.g., XLPE and EPR) would not be desirable for use at such high temperatures as indicated above, particularly in the mechanically-hostile environment of a transformer. Mechanically-hostile because of the level of mechanical stresses to which the transformer phase(s) would be subjected, in both the horizontal and vertical directions, due to short circuits to which the transformer will be

exposed. Cables are OK for use as transmission or distribution conductors as they are generally not subjected to the level of mechanical stress which they would see if used in a transformer.

23. With respect to the presence of the magnetic field, power transmission cables would be undesirable for use in a transformer environment. The metallic screen would provide an excellent eddy current path, leading to undesirable losses in the transformer. Furthermore voltage will be induced in the metallic screen, this voltage being of the same order of magnitude as in the conductor. In light of the above discussion, it is my opinion that a conventional electric power transmission cable would not work as a winding in a high power transformer.

24. While I have little practical experience in the field of design of transmission and distribution cables, I believe that I am qualified to state that those who design of transformers and those who design cables are concerned with completely different sets of constraints.

25. In the Examiner's Office Action, the Examiner asserts in his grounds for rejection that Grimes et al. discloses a transformer with windings, cooling ducts and duct sticks. The Examiner asserts that Grimes does not disclose the specific cable used for windings, but Elton discloses the electric cable configured for use with the electric device. The Examiner refers to column 1, lines 15-25 of Elton.

26. In my opinion, the Examiner has not described an operative combination. Grimes is not a high power inductance device. Rather, Grimes discloses a construction which utilizes conventional rectangular core-coil configuration with layer windings. This is a form that has and continues to be used in distribution and very small power devices, typically with an upper limit of 10,000 KVA and a primary voltage of 69,000 V.

27. Grimes is a conventional liquid cooled and liquid insulated transformer employing a strip conductors, and spacers, called duct strips, for creating liquid cooling ducts or channels in the winding. The uniqueness of Grimes lies solely is the thermal sensing device and the method by which it is applied and employed to measure temperature in the oil channel or duct.

28. Grimes does not confine the electric field in the winding as in the present invention. Indeed, this is why Grimes employs a vessel for containing the device and a liquid insulation for insulating the device. In addition, the liquid provides cooling.

29. The present invention does not require liquid cooling, nor does it require external insulation. The winding itself is insulated.

30. The strip conductor in Grimes has an insulated coating, but this is not sufficient to insulate the winding. At best, it provides intra-winding insulation. However, the insulation to ground is

provided in part by the liquid coolant. In the present invention, the covering on the cable provides intra-winding insulation as well as insulation to ground without the necessity of a liquid coolant or liquid insulation. This is because the electric field is totally confined within the winding.

31. Elton appears to disclose a cable which has a pyrrolized glass inner and outer layer separated by an insulation layer. Elton also discloses the use of the pyrrolized glass layer as part of the winding of an electric machine and as part of an insulation system for a shielded housing. Elton does not disclose or suggest that the arrangements described herein would be useful in a transformer.

32. It is difficult to see how the arrangement of Elton could be incorporated in the transformer design of Grimes without severely deforming, and hence possibly damaging, the structure which, in my view, could lead to failure of the device.

33. Elton does not describe a winding for a transformer, nor does the passage cited by the Examiner suggest that Elton's device could be used as a winding. Elton's invention addresses, simply, the dielectric integrity of a cable intended to supply power to a device; an insulation for a rotating machine; and an insulated housing. Elton's cable does not address the mechanical or thermal issues that would need to be addressed if such a cable was intended to be used in a transformer winding.

34. It is generally well known by engineers that a good dielectric is useful in a winding, but the Examiner's statement regarding the utility of Elton does not thereby show that Elton would be useful in the arrangement of Grimes.

35. Elton does not encounter the problems associated with high electric field stress in a confined area. For example, if one reasonably assumes that Elton would include a metallic shield jacket, as transmission and distribution cables do, and if one uses Elton in its entirety as the winding of a transformer, the metallic shield would have a current induced therein, and thus would become an extraneous current path which would certainly result in heating of the device. Likewise, the outer jacket would certainly contain the product in the shield. If the outer jacket or sheath is a conductor, additional heat would be produced due to the induced currents therein as well. There is no telling what such heat would do to the remaining portions of Elton's device, but Elton does not even consider the problems of heat in designing a high power cable.

36. By the same token, use of the device of Elton in a transformer having relatively high heat concentration could easily result in failure.

37. I am not a cable expert and thus I can not provide expert testimony as to the functionality of cables in general. As an engineer familiar with transformer design at the time the invention was

made, I would not have considered using a high power cable designed for ambient temperature operation or the components of such a cable in the high temperature confined region of a high power transformer.

38. Takaoka discloses a conductor having insulated and uninsulated strands. The purpose of the feature in Takaoka is to reduce the skin effects "associated with self-induced currents in a transmission and distribution cable." In my opinion, it has nothing to do with reducing eddy currents in the winding of a transformer. In the present invention, the insulated strands reduce eddy current losses by restricting the paths for the currents between the conductive strands. However, it is necessary to employ at least one uninsulated strand to make contact with the semiconducting layer in order to set up an equipotential field. In Takaoka, the outer strands are insulated because that is where the skin effect current flows. Accordingly, the reference teaches away from the invention because in the invention the outer strand or strands are uninsulated for a different purpose.

39. It appears that the Examiner recognizes that Takaoka is a transmission and distribution cable because he contends that Takaoka teach that it would be obvious to modify the cable of Grimes in view of Elton and with Takaoka to increase power handling capacity. In my opinion, Takaoka has nothing to do with a cable winding where power is transformed, much less reducing eddy currents which develop when the cable is used as a winding in an electromagnetic device.

40. In the present invention, the insulated strands reduce eddy current losses by restricting the paths for such currents between the conductive strands. Eddy currents and induced in the windings as a result of the exposure of the windings to high magnetic fields in the transformer. These currents are problematic in these applications because they create electrical losses which are manifested as thermal energy (heat), which in turn causes a number of reliability problems in transformers. The arrangement in Takaoka is not subjected to these problems because it is my understanding that transmission and distribution cables are not subjected to the localized high magnetic field one would encounter in a transformer.

41. Although I am not a cable expert, it would appear that the size and considerations in Takaoka relate to transmission and distribution cables. These size and considerations are not automatically translatable into dimensional criteria for transformer windings.

42. I further state that all statements made herein to my own knowledge are true and that all statements made herein on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment or both under Section 1001 of Title 18 of the United States Code and that such any willful false statements may jeopardize the validity of the application or any registration resulting therefrom.

K L Linsley

Date 6/19/01

Ken Linsley